SINGLETON

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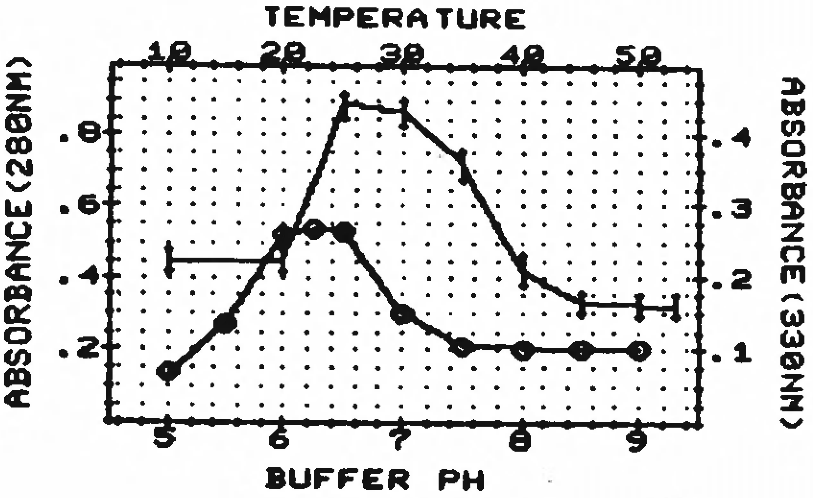
SCIENTIFIC PLOTTER

By Paul K. Warme



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IMPROVEMENTS OF SCIENTIFIC PLOTTER

1. Since one does not always know beforehand the exact number of data points to be entered, the question "# POINTS TO BE TYPED" has been omitted. Instead, you should type a Y value of 9999 after you have entered the last data point.

2. For convenience, the program automatically switches to graphics mode when the plot is being updated and then switches back to text mode before the next question.

3. Typing Control A switches the program into the Automatic mode of operation. In Automatic mode, the default values are used instead of user input. This mode ends when any error occurs or when a default value is outside the range of permissible values or when you type any key. The program also switches out of Automatic mode when the SAVE FILES segment of the program is reached.

4. A SYNTAX ERROR occurs when you append a volume, drive or slot number after a file name. For this reason, a new Control D function has been added to both Scientific Plotter and Curve Fitter. Typing Control D sends the previous letters typed on an input line to the disk operating system. For instance, you could list the catalog of drive 2 by typing CATALOG, D2 followed by Control D on any input line. From that point on, drive 2 will be used for disk input or output. Thus, when you want to access a disk file with a different volume, drive or slot number than the one currently in effect, you should first list the catalog for that disk (or perform any other disk operation) using the Control D option.

FEATURES OF THE SCIENTIFIC PLOTTER PROGRAM

Scientific Plotter makes it easy for scientists to produce professional-looking graphs of scientific data. Since the user selects the exact height and width of the axes, he can choose the best proportions for presenting his data. This is like having graph paper in an infinite variety of grid sizes, including logarithmic and semi-logarithmic scales. Numeric labels are printed automatically on the axes at user-selected intervals. Data may be input from disk or from the keyboard or the data may be calculated by a user-defined subroutine. A versatile scaling technique permits you to enter data in natural (measured) units and then scale or offset the data before plotting it. To facilitate plotting and comparison of multiple sets of data on the same graph, you may choose from among 20 different plotting symbols in 4 size ranges. With the larger symbols, you may also select filled or open symbols. Variable-length error bars may be superimposed on the symbols in order to indicate the range of error for each point. Text labels may be positioned anywhere on the graph by moving a flashing cursor to the desired position and then typing the label. An alphabet of 76 letters, including scientific symbols, is available to print labels in four different orientations (at 90 degree angles).

Here are some other features that you will appreciate:

*Full screen resolution of 280 x 192 points

*Switches back and forth between text mode and graphics mode at the touch of a key

*Format files and data can be saved on disk for later re-use

*Plots data in one, two or four quadrants

*Independent scaling on two, three or four axes

*Seven different colors can be individually selected for axes, symbols and labels. This is terrific for making color slides.

*Grid dots may be plotted at tick mark intervals for easy evaluation of point locations.

*Data may be input as X, Y pairs or as Y values at a constant X interval.

*Demonstration plots on disk help you to discover the versatility of this system.

Best of all, using the Scientific Plotter program is much easier and faster than plotting the data by hand. Many convenient features have been designed into this program from the ground up. At any time, you may erase the graph and replot it with any desired changes. All previously-selected options automatically become the defaults, so that you can quickly step through the procedure up to the point where a change is required. The program computes the allowable range for input values and warns you when you mistakenly enter a value that is out of range. After the best format for a particular type of graph has been selected, that format can be saved on disk for subsequent use with similar data. With all of these features, it should come as no surprise that this program was written by a scientist who

understands the plotting requirements of other scientists.

HOW TO PRODUCE A BACKUP DISK

Although this program is copyrighted, you have permission to make copies for your own use on a single machine. Thus, your first action should be to copy the master disk to another disk as follows:

1. Mount the master disk and type RUN SCIPLOT, and then press the RETURN key (from now on, you should always press RETURN after entering your command or response). After a short time, a whizbang logo will appear and then the screen will be erased and the question, "NAME OF FORMAT FILE() ? <NONE>" will appear. Now, type control Q (hold down the CONTROL key and press the Q key) to stop the program.

2. Mount the slave disk and type SAVE SCIPLOT. After the program has been saved on disk, type BSAVE PKWDATA,A$7000,L$670 in order to save the machine language part of the program.

3. The demonstration plot files may be saved on your slave disk later as described below.

METHODS OF USER INTERACTION

Before you actually use this program, there are a few things that you should know about. The program will guide you through the plotting procedure by printing a series of prompting questions. Each question is followed by another clause within parentheses (). The second clause specifies the range of permissible responses, based on previous information. If you type a response outside this range, the program will ring the bell and print "INVALID ENTRY; CHECK (RANGE)". Then, the previous prompting question will be printed once more and you will be allowed to type a different response. If nothing is printed within the parentheses, your response is unrestricted. Each prompting question also contains a third clause, enclosed in <> brackets. This indicates the default value, which is initially blank, but later, it will contain the most recent response to this question. Default values may also be read from a file stored on disk. If you wish to accept the default value, just press the RETURN key. Otherwise, type a different response, followed by RETURN. This method of saving the last response as the default value will save you a great deal of typing. Of course, if nothing is printed within the <> brackets, no default value is available and you must type some valid response.

CONTROL CHARACTERS FOR EDITTING AND PROGRAM CONTROL

As summarized in flowchart I, a number of control characters

cause special actions by the program. The back arrow key (Control H) deletes the last character that you typed and Control X deletes the entire input line. Control G switches to Graphics mode so that you can examine the graph and Control T switches back to Text mode. Control C switches to graphics mode and displays a blinking Cursor (+) on the graphics background. You may move the cursor around by turning the game controls until the cursor reaches the desired position. Then, press any key to register that position and return to text mode. The cursor value is printed as if you had typed it, so if you press RETURN, the cursor position will be taken as your response. Control P allows you to select a Print device for subsequent output. After the Control P, type the single-digit number denoting the slot occupied by the printer controller or type 0 to restore normal screen output. Control Z may be typed at any time to escape from the normal sequence of prompting questions and jump to the SAVE FILES section of the program. Control Q is the signal to Quit the program entirely and return to BASIC. All other Control keys are ignored during user input.

HOW TO RUN THE DEMONSTRATION PLOTS

The master disk contains five demo plots that will introduce you to some of the features of the Scientific Plotter program. It is suggested that you try at least one of these demonstrations before attempting to plot your own data. Most of us learn faster by example than by reading a manual. It's also more fun to learn by example.

To start the program, mount the master disk and type RUN SCIPLOT or, if the program has already been loaded, just type RUN. After the whizbang logo is plotted and the screen has been cleared, the program prints:

```
NAME OF FORMAT FILE() ? <NONE>
```

Since nothing is printed in the range field within (), your input is unrestricted. If you simply press RETURN, the default value <NONE> will be entered as your response and this will mean that you do not want to load a format file from disk. However, for this demonstration, you should type PLOT3000, so that the format file for the first demo plot will be read from the disk. In other words, the default values within <> for all of the other questions will be read from the disk file called PLOT3000. Thus, you may just press RETURN after each question and the program will automatically draw the graph. Since our objective is to learn how to use the program by example, you should read the default values printed after each question and try to understand how these responses affect the graph being plotted. If you don't understand something, you may look up that question in the table of contents and read the explanation given later in this manual. Alternatively, you may just press RETURN and see what happens. At any time, you may type Control G to see the graph or type

Control T to see the questions. If you want to ignore the questions and just watch the graph while it is being constructed, you may type Control G and then press RETURN repeatedly to step through the program.

When the program reaches the point where labels are being printed on the axes, it is a good idea to type Control T and start reading the questions, because you will probably want to save some demo files on your slave disk.

In the case of PLOT3000, the data are calculated by subroutine 3000, so you will not need to save the data on disk (unless you wish to change subroutine 3000). Thus, when the question:

```
    WRITE DATA FILE NAME() ? <NONE>
```

appears, just press RETURN and no data file will be saved. However, in some of the demo plots, you will want to save the data files on your slave disk. Thus, you should mount your slave disk before typing the file name and pressing RETURN. Note that if you try to write a file on the write- protected master disk, the program will be stopped by a WRITE PROTECTED error.

The next question asks whether you want to save the format file:

```
    WRITE FORMAT FILE NAME() ? <NONE>
```

You will probably want a copy of this on your slave disk. If so, be sure to mount your slave disk before typing the file name and pressing RETURN.

Now, you have the option of saving the graph on disk as a picture file:

```
    WRITE PICTURE FILE NAME() ? <NONE>
```

This option is useful if you want to make a hard copy of the graph using an auxiliary printing program, but normally, you will skip over this by pressing RETURN.

At this point, you may decide to review a graph already saved on the disk. The picture file called PICTURE is included on the master disk so that you can try out this option. After the program asks:

```
    READ PICTURE FILE NAME() ? <NONE>
```

mount the master disk, type PICTURE and press RETURN. This graph will appear on the graphics screen when you type Control G.

We are through with the first demonstration when the program prints:

```
    ERASE GRAPH(Y:N) ? <Y>
```

Since the default is Yes, just press RETURN and then we are ready to construct another graph. Mount the master disk and type PLOT4000, PLOTLOG, PLOTDUAL or PLOTBAR in response to the question:

```
    READ FORMAT FILE NAME() ? <NONE>
```

PLOT4000 calculates data using subroutine 4000, PLOTLOG uses data file DATALOG, PLOTDUAL uses data file DATADUAL and PLOTBAR uses

data file DATABAR. PLOTDUAL and PLOTBAR may be run in sequence without erasing the other graph, in order to demonstrate plotting data on four independent axes. Most likely, you will not have any trouble producing these graphs if you merely press RETURN after each question. However, you may want to try modifying some of the responses in order to change the plotted results. If you get adventurous, you might encounter some unexpected results; however, the rest of this manual will help you over the rough spots as you loosen the apron strings.

DETAILED EXPLANATIONS OF PROGRAM OPTIONS

The Table of Contents lists each of the prompting questions asked by the Scientific Plotter program, in the same order that they are encountered in the programs. On the page number listed after each question, you will find a detailed description of the effects of your responses on the graphical outcome. Note that some of the questions are skipped over, depending on previous options that you have selected.

PROGRAM FLOWCHARTS

The easiest way to grasp the overall flow of the program is to look at flow chart A, which shows the major parts of the program and will direct you to one of the more detailed flowcharts B through G for further information. Flowcharts H and I pertain to user input; you should bear in mind that they are relevant whenever you are typing any response. Also, note that the control characters in flowchart I take effect immediately after you type them and they may be typed at any point in the input line. However, these control characters are not included as part of your actual response to the question.

READ FORMAT FILE NAME

If you want to load a format file previously stored on the disk, type its file name. Optionally, you may append a volume, slot or drive number after the file name (this is also true for all other file names used by this program). The default file name for this question is always <NONE>, so if you only type RETURN, no format file will be read and the default values will be whatever was previously answered for each question. If you have just started the program by typing RUN, all of the default values are blank, so you will have to type some valid response to each question.

DEFINE AXES SEGMENT (FLOWCHART B)

COLOR OF AXES

The colors allowed by this program are the same as those used with the HCOLOR command in BASIC, namely 0=black1, 1= green, 2=blue, 3=white1, 4=black2, 5=pink, 6=orange and 7=white2. If you don't have a color monitor, 3 is the best choice of color. The color selected in response to this question will be used for both the X and Y axes, for the tick marks, for the numeric labels, for the grid dots and for the frame around the axes.

If you would like to have a colored background for your graph, change the HGR2 command on line 96 as follows, inserting the desired background color number in place of the question mark:

```
    96 HCOLOR=?: FOR I=0 TO 191: HPLOT 0,I TO 279,I: NEXT
```

POSITION OF LEFT END

To leave room for y-axis char. label start at x≥30

This is asking you to enter the X and Y coordinates of the left end of the X axis. You will recall that on the high resolution screen, the coordinates of the upper left corner of the screen are 0,0 and the coordinates of the lower right corner are 279, 191. The easiest way to enter screen coordinates is to press Control C and then use the game controls to position the blinking cursor to the desired position. When you press any key, these cursor coordinates are printed on the response line, exactly as if you had typed them. Now, you may press RETURN to input these coordinates.

If you type the coordinates instead of using the cursor, you must type a comma between the X and Y coordinates. Also, note that the range values in parentheses require that you type an X value between 0 and 279 and a Y value between 10 and 181. This leaves at least 10 spaces (one line) above or below the X axis in order to print labels on the axis. Each character occupies a space 8 points wide by 8 points high.

POSITION OF RIGHT END

Here, you should enter the X and Y coordinates of the right end of the X axis. Again, the cursor is the easiest way to enter the coordinates. The program does not permit crooked axes, so it automatically sets the Y coordinate equal to the Y coordinate of the left end, even if you enter something different. The X axis is now drawn on the graphics page (type Control G to see it).

MINIMUM X VALUE

Now, you are asked to assign a numeric value to the left end of the X axis. Any data values smaller than this cannot be plotted and will cause a BAD POINT message when the data are

plotted. The minimum value does not have to coincide with a numeric label or gridmark; any reasonable value will do.

MAXIMUM X VALUE

Your response to this question should be a value larger than the X value of any data point, otherwise a BAD POINT message will result. The maximum value need not coincide with a numeric label or grid mark. The values that you specify for the minimum and maximum will be used to determine where each data point should be plotted along the X axis.

LOG SCALE (Y:N)

If you want your data values to be converted to logarithmic form before plotting, answer "Y" to this question. If your data are already in log form, you should answer "N", but when you label the axis later, be sure to indicate that the scale is logarithmic.
LOG BASE (LOG:LN)

If you answered "Y" to the previous question, you must now select either LOG (base 10 logarithm) or LN (base e logarithm). The program then prints the new minimum and maximum values for the X axis in log units.

VALUE OF FIRST LABEL

One problem with many other plotting programs is that it is difficult to make the numeric labels on the axes come out in nice, round units. Scientific Plotter lets you have complete control over the number of digits printed for labels. First, you specify the value of the first (leftmost or minimum) value to be labelled on the X axis. Later, you will select the interval between labels in nice, round units. For each numeric label, the number of digits to the right of the decimal point will be the same as the number in your response to this question. For example, if you want your labels to run from 10 to 11 at intervals of 0.2, you should type 10.0 here. If you prefer intervals of 0.25, you should type 10.00 here, so that the labels will be 10.00, 10.25, 10.50, 10.75 and 11.00.

INTERVAL BETWEEN LABELS

Now it is time to select the interval between labels on the X axis, in the same units as were used for the previous question. You should choose an interval that will give a reasonable number of labels, usually 4 to 10 of them. If all of the numbers will not fit on a single line, the program automatically prints the labels in two lines. If there are too many labels to fit on two

lines, the labels are printed vertically. If more than 25 labels are requested, the program gives up, prints "TOO MANY LABELS" and returns to the "VALUE OF FIRST LABEL" question.

If everything has turned out well up to this point, the labels are printed (type Control G to see them) and large tick marks are drawn at each labelled position. If the Y coordinate of the X axis is less than 90, the labels are printed above the X axis; otherwise, they are printed below the X axis.

If you don't like the way the labels are printed, you may type Control Z, which will route you through the Save Files section of the program and then you may erase the screen and try again. For instance, if one of the labels occurs too close to the left or right end of the X axis, go back and change the label options or change the minimum or maximum X value.

TICK MARK INTERVAL

Usually, you will want some finer gradations on the X axis, so here you may specify an interval of the appropriate size for small tick marks. The interval should be given in the same units as were used for the "VALUE OF FIRST LABEL" question. The tick marks will start at the position of the first label and extend in both directions to the ends of the X axis. Generally, you will want the small tick marks to overlap the larger tick marks plotted beside each numeric label. Thus, you should choose a tick mark interval which evenly divides the interval between labels.

Another consideration in choosing the tick mark interval is that this also governs the interval between grid dots, which may optionally be plotted at a later stage.

32, 160

POSITION OF BOTTOM END

Next, we will define the Y axis, much as we did for the X axis. It is most convenient to use the cursor (type Control C) to enter the position of the lower end of the Y axis. You will note that the range values require an X coordinate between 18 and 261, in order to leave at least 18 spaces (2 characters) on the left or right side for printing labels. If you wish to print labels wider than this, be sure to allow enough space (each letter is 8 by 8 dots). Remember that numeric labels are printed horizontally along the Y axis, but alphanumeric labels may be printed vertically.

0, 10

POSITION OF TOP END

Again, you may use the cursor to select the upper end of the Y axis. SInce only strictly vertical axes are allowed, the X coordinate of the top end is automatically set equal to the X

coordinate of the bottom end, regardless of what you enter.

0

MINIMUM Y VALUE

We are now ready to set up the scale for the Y axis, just like we did for the X axis. Enter a value which is smaller than the smallest Y value expected for any data point.

100

MAXIMUM Y VALUE

Here, you should enter a value larger than the Y value of any point. Note that these maximum and minimum values do not have to coincide with any numeric labels or tick marks. You are completely free to choose your own scale for both the X and Y axes.

N

LOG SCALE (Y:N)

If you wish to enter Y values in normal units and have them converted to logarithmic units before plotting, answer "Y" to this question.

N

LOG BASE (LOG:LN)

If you answered Yes to the last question, you should now type LOG for base 10 or LN for base e logarithmio conversion. Then, the program will print the new minimum and maximum values in log form.

0

VALUE OF FIRST LABEL

As in the case of the X axis, you will now select the smallest value at which a numeric label will be printed. This need not coincide with the bottom end of the Y axis. The number of digits to the right of the decimal point will be the same for each numeric label as you specify here.

70

INTERVAL BETWEEN LABELS

Now, you may select the interval between labelled values on the Y axis. Labels are always printed horizontally on the Y axis. If you request more than 15 labels, the program will print "TOO MANY LABELS" and will return to the "VALUE OF FIRST LABEL" question. Otherwise, large tick marks will be plotted at each labelled position and the numbers will be printed (type Control C to see them). If the X coordinate of the Y axis is less than 150, the labels are printed to the left of the Y axis; otherwise, they are printed on the right side.

In the event that you are producinq a four quadrant plot, it will probably turn out that the X and Y axes don't intersect at the riqht point. There is an easy way to correct this. Just type Control Z to exit to the SAVE FILES section of the proqram. Without saving any files, step through to the "ERASE GRAPH(Y:N)" question and answer N, so that the present qraph remains on the screen. Next, you will be asked for the name of a format file, to which you should answer NONE. Now you are back to the part of the program where you define the axes. If you want to move the X axis, use the cursor to define the new position, so that it will intersect the Y axis properly. Alternatively, if you want to move the Y axis, press RETURN after all of the questions until you reach the "POSITION OF BOTTOM END" question. Then, use the cursor to define a new Y axis which will intersect the X axis at the correct point. After moving one of the axes, type Control Z to exit and step through to the "ERASE GRAPH(Y:N)" question once more. You should now erase the qraph and step through the axis definition part of the program by pressinq RETURN after each question. Your axes should now intersect perfectly.

TICK MARK INTERVAL

2 You may now select the interval between tick marks along the Y axis, using the same units as were used for the last two questions. Choose an interval which evenly divides the interval between labels, so that the small tick marks will coincide with the large tick marks beside the numeric labels. Tick marks will then be plotted above and below the first (lowest) larqe tick mark until the ends of the axes are reached.

Y DRAW GRID DOTS (Y:N)

It is often useful to plot grid dots over the entire qraph in order to provide guidelines for estimating the values of particular points. We find that plotting qrid dots works better than plotting straight lines, because lines tend to obscure much of the graph, unless they are widely spaced.

Grid dots are always plotted at intervals qoverned by the tick mark intervals along the X and Y axes. You should think of each dot as the intersection of two perpendicular lines drawn through a pair of tick marks.

FRAME AXES (Y:N)

N If you answer Y to this question, the proqram will draw a rectangular frame which intersects both ends of both the X and Y axes. If you have constructed a one or two quadrant graph, one or two of the sides of the rectanqle will coincide with the axes drawn previously, but this does no harm.

DATA INPUT SEGMENT (FLOWCHART C)

There are three ways to input data that you want to plot: you can type the values on the keyboard, you can read the data from disk, or you can define a subroutine that calculates the data. Array D(500) is always used to store the data, regardless of the source. If X, Y pairs are being plotted, D(1) and other odd numbered elements are used to store the X values, while D(2) and even-numbered elements store the Y values. Up to 250 points may be stored. If only Y values are being entered at a constant X interval, 500 points starting from D(1) may be stored. If Y values and error bars are stored, D(1) holds the first Y value, D(2) stores the first error bar and up to 250 points may be plotted. If X, Y pairs plus error bars are being plotted, D(1) is the first X value, D(2) is the first Y and D(3) is the first error value. In this case, no more than 166 points can be stored in array D. Of course, if you have sufficient memory capacity in your computer, you may increase the dimensions of array D and the value of MAX in program line 12.

Element D(0) is always set equal to the number of values (not points) actually stored in array D. It is important to realize that D(0) will be either one, two or three times the number of points to be plotted, depending on whether X values and/or error bars are being input.

USE SAME DATA (Y:N)

If you answer Y to this question, the program skips this entire section and continues with the PLOT DATA Segment, using the previous input data.

X,Y PAIRS (Y:N)

This question asks you whether your input data will include both X and Y values. If only Y values are to be entered, you will have a chance later to specify the interval between X values.

ERROR BARS (Y:N)

Here, you should indicate whether your data will include error bars for the Y values. Error bars are always drawn an equal length above and below the corresponding Y value; so the values input for error intervals should be half their total length. Also, note that any scaling or logarithmic conversions subsequently performed on the Y values are also performed on the

error intervals; thus, the error bars should be entered in the same units as those of the Y values.

READ DATA FILE NAME

If you wish to input data from a disk file, type the file name here. Otherwise, type NONE in order to skip over this part of the program.

It is easy to create data files that are compatible with Scientific Plotter. Just be sure that the data are stored as a text file in the format described above under the heading "DATA INPUT SEGMENT". Data stored on the disk by the APPLAB Data Acquisition System, the Curve Fitting Program (available soon) and other programs available from Interactive Microware, Inc. are directly compatible with Scientific Plotter.

The following general method may be used to store data on disk for later plotting by this program:

```
    10 DIM D(500)
    1000 CD$=CHR$(4):F$="PLOTDATA"
    1010 PRINT CD$;"OPEN ";F$:PRINT CD$; "WRITE ";F$
    1020 FORI=0 TO D(0): PRINT D(I):NEXT
    1030 PRINT CD$; "CLOSE ";F$
```

Between statements 10 and 1000, you could insert any program that stores data values in array D.

FIRST POINT TO BE USED

This question is asked only if you are reading data from a disk file. In some cases, you will only want to plot some of the points from a larger data file. If so, enter the number of the first point to be read. Enter 1 (one) to start reading at the first value. Notice that since you have already indicated whether X, Y pairs or error values are stored in the data file, the program can automatically calculate the position of the first requested data point in the file.

INTERVAL BETWEEN POINTS

If you are reading data from a disk file, this question allows you to skip over some of the points and plot only selected points. Type 1 if you want every point to be plotted, type 2 to plot every second point and so on.

This option may be used when you want to avoid congestion by plotting all of the points using a small symbol and then go back and superimpose a larger symbol on selected points at constant intervals. In this way, you can distinguish among several curves plotted on the same graph.

DATA CALCULATION SUBROUTINE

Instead of reading the data from disk, you may use a subroutine to calculate the data. If you don't want to do this, type 0 (or any number less than 3000) and the program will skip to the keyboard data entry routine. Seven different subroutines may be entered, starting on line numbers from 3000 to 9000. The starting line number must be evenly divisible by 1000. Subroutines 3000 and 4000 are predefined for the demonstration plots, but you may change them as desired.

A data calculation subroutine could be used to draw a theoretical curve through data points already plotted or to smooth the data or to do a least squares fit of the data. You could even use one of these subroutines to read incompatible data from the disk and transform it into the form used by this program. In short, you are free to generate data in any way that you please, as long as you store the data in the D array in the proper form (see the discussion following "DATA INPUT SEGMENT").

POINTS TO BE TYPED

If you haven't already entered data from the disk or used a data calculation subroutine, this question will be asked. For each point, you will then be asked to enter the X value, Y value and +/- Error, as appropriate. The default value will be the one last stored in that element of the D array. The purpose of this feature is to make it convenient for you to edit your data. If the default value is correct, you can just-press RETURN.

It is possible to edit data read from disk or data produced by a calculation subroutine. To do this, type Control Z at any point and skip through the program until you come to the DATA INPUT SEGMENT. Then, instead of reading the data from disk or calculating it, answer the questions as though you want to type the data on the keyboard. Step through the values by pressing RETURN after each question until you come to a value that needs to be editted. Now, enter your correction and press RETURN repeatedly until all values have been re-entered.

Later in the program, you will have the opportunity to save your data on the disk. However, if any scaling, offset or logarithmic conversions have been carried out, your data will be saved in the converted form, not in its original form as you typed it. Therefore, if you want to save your data on disk before any conversions take place, you should type Control Z and save the data as soon as you finish typing it.

SCALE DATA SEGMENT (FLOWCHART D)

At this point, the data have been entered in one form or another, but some conversions may be needed before the data can be plotted. The program first prints the minimum and maximum values entered for the X and Y data, in order to remind you what operations are needed to prepare the data for plotting.

FIRST X VALUE

If you have entered only Y values, it is necessary to tell the program where to begin plotting on the X axis. Your response to this question should be the minimum (leftmost) X value for the first data point.

X INTERVAL

This applies only when X values have not been entered explicitly. Starting from the first point selected by the previous response, the remaining points will be plotted at equal intervals along the X axis, as requested by your answer to this question. In this case, the following two questions are skipped, so you must enter your values in terms of the final units for plotting.

X SCALE FACTOR

If you have entered X values, you may now select a scale factor, which will multiply each X value. If no scaling is required, type 1 (one) as your answer.

X OFFSET

You may also add a constant offset to each X value. This might be used, for example, if your X values range from 10,000 to 10,001. Offsetting each value by -10,000, the plotted values will range from 0 to 1. If no offset is desired, type 0 as your answer.

The plotted X value is calculated by the formula:
X plot=X scale*(X input + X offset)
If a logarithmic scale has been selected for the X axis, the base 10 or base e logarithm of X plot is calculated as the last step.

Y SCALE FACTOR

This works just like the X scale factor. If no scaling is needed, type 1.

Y OFFSET

The Y offset is used the same way as the X offset was used. The formula used to calculate the Y values to be plotted is:

Y plot=Y scale*(Y input + Y offset)

After this conversion, the base 10 or base e logarithm of Y plot is taken if a log scale was selected for the Y axis.

PLOT DATA SEGMENT (FLOWCHART E)

Hurray! We are finally ready to actually plot the data. It is important to realize that you can plot more than one set of data on the same graph by skipping over the DEFINE AXES SEGMENT and inputting more data. Each set of data can be plotted using a different color and a different symbol. You can also define a second set of axes without erasing the first axes, and plot other related data on the scale of the new axes. If there is room on the screen, you could even plot two or more separate graphs on the same screen.

SYMBOL

There are 20 different plotting symbols in 4 different sizes. The smallest symbols fit within a 3 x 3 square, the medium sizes are 5 x 5 and 7 x 7 and the largest symbols are 9 dots wide by 9 dots high. Symbol 1 is a plus (+) sign and symbols 2 through 4 are progressively larger + signs. Likewise, symbols 5 through 8 are crosses (x), symbols 9 through 12 are diamonds, symbols 13 through 16 are squares and symbols 17 through 20 are circles of progressively larger size. The smallest circle (17) is a single point. All of the symbols are symmetric about their centers and the actual data point being plotted is always located at the exact center of the symbol.

SOLID SYMBOLS (Y:N)

The larger symbols in each set have some open space in their centers. If you answer Y to this question, the centers will be filled in with the same color. This feature could be used to distinguish duplicate measurements of the same type or for any other occasion where you want to differentiate two different, but related, sets of data.

SYMBOL COLOR

You are now asked to select a color for the symbols. These colors (0 to 7) are the same as those listed under "Color of Axes". If you want to erase some symbols already plotted, use color 0 or 4 (black). If you don't have a color monitor, color 3 (white) is the best choice.

CONNECTING LINES (Y:N)

An affirmative response here will cause the program to connect adjacent points with straight lines. The color of the lines will be the same as the current symbol color. If you want your curve to look continuous, without superimposed symbols, use symbol 17 (a single dot) to plot the points.

After you respond to this question, the points are plotted and error bars and/or connecting lines are drawn (type Control G to see them).

LABEL GRAPH SEGMENT (FLOWCHART F)

LABEL 1 to 5

Scientific Plotter includes a very versatile method for labelling your graph. You may define as many as 5 strings of up to 255 characters. Each string may contain several labels, so you should have no trouble displaying as much text as you want. As outlined in flow chart F, the following characters have special significance:

@: Selects Location

After you type @, the next two numbers define the X and Y coordinates where the next label will be written. The two numbers should be separated by a comma. The easiest way to select the location for a label is to use the cursor. Just type Control C and the cursor will appear on the graphics screen. Use the game controls to position the cursor at the correct spot and then press any key. The cursor coordinates will be printed on the input line, as if you had typed them.

Bear in mind that each character begins at the lower left corner and ends at the lower right corner, ready to print the next character. Plotting symbols begin and end at the center of the symbol.

&: Select Rotation

Characters can be plotted in any of four orientations. The single digit number following the & should be 0 for normal horizontal text, 1 is for vertical text reading downward, 2 is for upside down text reading leftward and 3 is for vertical text reading upward. Orientation 1 would be used for labelling a Y axis on the right side, whereas orientation 3 would be used for labelling a Y axis on the left side of the screen. Orientation 0 would be used for most other labels. Unless you enjoy standing on your head, orientation 2 is not recommended for any labels.

The orientation remains con tant until it is changed by

another & command.

#: Select Color

Labels may be written in any of the 8 colors recognized by the HCOLOR directive. To select a color, type the # sign, followed by a single digit number from 0 to 7. Color 3 (white) is best for black and white monitors. Colors 0 and 4 (black) may be used to erase a label.

IMPORTANT: The color you select does not take effect until the next @ command; thus, you should type the # command before an @ command. The color remains in effect until it is changed by another # command.

$: Select Special Character

Certain special characters can only be printed by typing a dollar sign, followed by a one- or two-digit number. All of the normal Ascii characters (numbers 32 through 95) retain their standard numbers, as listed on pages 138-139 of the Applesoft manual. Most of these can be typed on the keyboard, without using the $ command. However, the left square bracket (number 91), the backward slash (number 92) and the underline character (number 95) cannot be typed on the keyboard, so you will have to use the $ command for these. Also, you will have to use the $ command to print @ (64), & (38), # (35) and $ (36), since these are special characters in this context.

Characters numbered 1 through 20 are the plotting symbols; these correspond to Control A through Control T. Since Control letters are used for other purposes in this program, you will have to use the $ command to print these symbols. You will recall that these plotting symbols start and end at the center of the symbols, so you should type a space after them, before typing the next character.

The following special characters are also available: 21 is a degree symbol, 22 is a copyright mark, 23 is a summation sign, 24 is an integral sign, 25 is a left arrow, 26 is a right arrow, 27 is a down arrow, 28 is an up arrow, 29 is a square root sign, 30 is the Greek letter pi and 31 is a divide sign. Symbol 96 is a solid white square and it differs from other characters in that it starts and ends at the lower left corner. It is normally used as a cursor, but it can be used to erase a character by setting the color to black and then printing this symbol ($96). A series of alternating $96 and spaces will erase a line of character.

OTHER CHARACTERS

All other letters are included in a label by merely typing the letters in the desired order. Up to 255 letters or commands may be included in each of the 5 label strings. Some examples will clarify this:

```
    #3@10,200$26LABEL 1
```

This string selects color 3 (white) and printing will begin at X=10, Y=20. The rotation will be 0 (normal horizontal). The first symbol actually printed will be a right arrow ($26), and then "LABEL 1" will be printed. Now, the string:

```
    @10,100 LABEL 2
```

will print "LABEL 2" at x=10, Y=100, without changing the color or rotation.

```
    #0@10,100LABEL 2
```

would erase LABEL 2 because color 0 is black and we have selected the same location for printing. Note that lal of these strings may be concatenated together in the same label string, with no spaces between them, and the result will be exactly the same. It does no harm to plot the labels more than once, as you might do when plotting several data sets on the same graph.

SAVE FILES SEGMENT (FLOWCHART G)

You now have the option of saving your data file, format file or the graph itself (as a picture file) on disk. You can exit to this part of the program at any time by typing COntrol Z. In all cases below, the file name defaults to NONE, so you may simply press RETURN if you don't want to save a file. This provides an extra measure of protection against accidentally destroying a file that you wanted to keep. Optionally, you may type a volume, slot or drive number after the file name.

WRITE DATA FILE NAME

If you enter a valid file name here, your data will be saved on disk. Remember that if you have scaled or offset the data or converted to log form before plotting, the data will be stored on disk in the converted form. To circumvent this, type Control Z immediately after inputting the data.

WRITE FORMAT FILE NAME

Now, you may save the current list of responses to all questions on the disk as a format file. Later, if you want to construct a similar graph, just enter the name of this format file after the READ FORMAT FILE NAME question and from there on, you can type RETURN after all questions except those where some change is desired.

WRITE PICTURE FILE NAME

This feature is included so that you can save a graph on disk for later review or for output to a graphics printer. Type any valid file name or just press RETURN if you don't want to do this.

READ PICTURE FILE NAME

If you have saved a graph on disk, this option will allow you to quickly review it. To do this, type the file name, type Control G and then press RETURN. The picture will appear on the screen and, of course, will erase whatever was on the screen before. For convenience when you want to review more than one picture file, the program repeats this question if you employ this option. To skip this option, just press RETURN.

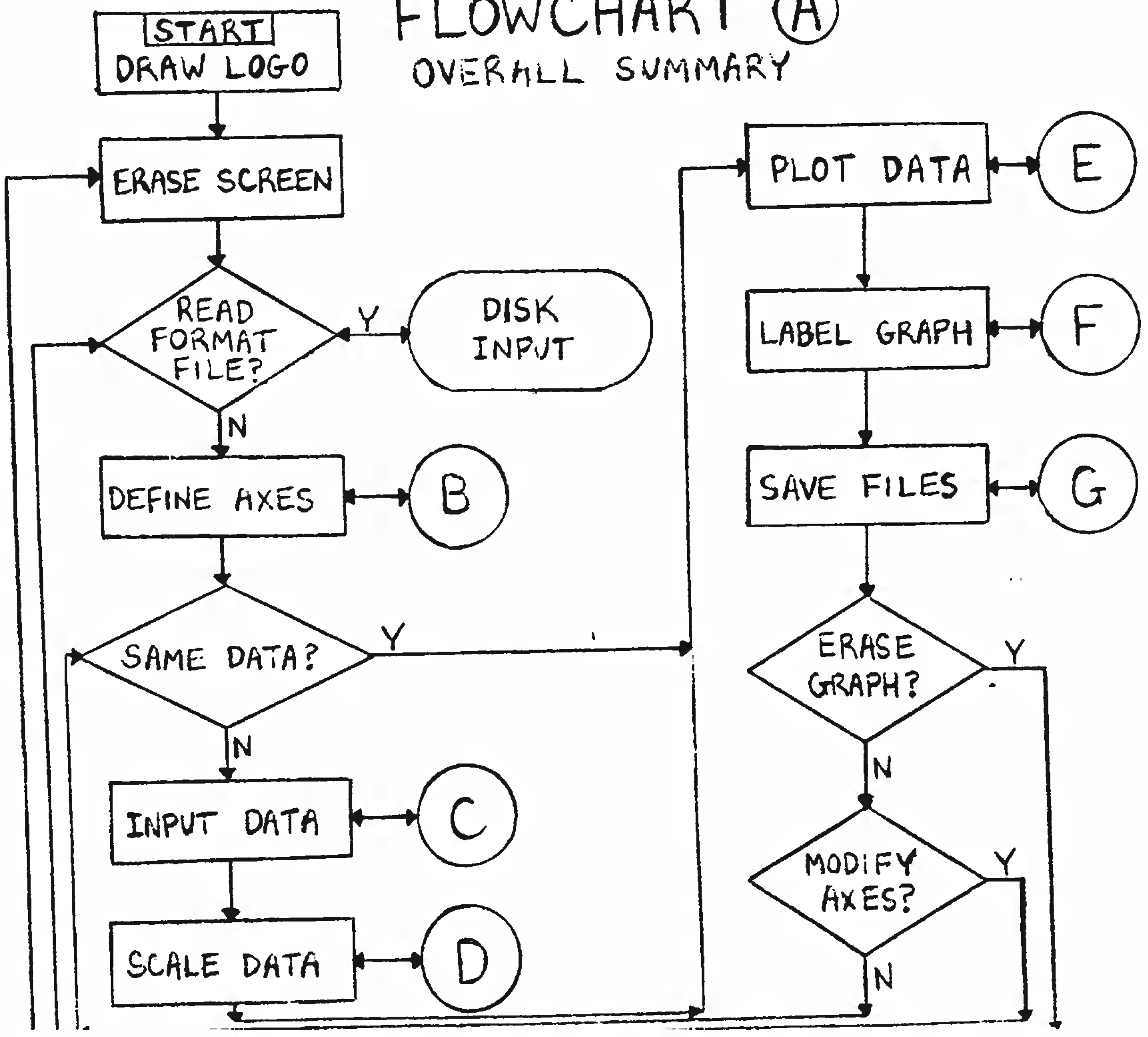
ERASE GRAPH (Y:N)

If you answer Y to this question, the screen will be erased and the program will start over. You should type N if you want to add a new set of axes or plot more data on the same set of axes. To stop the program, type Control Q.

MODIFY AXES (Y:N)

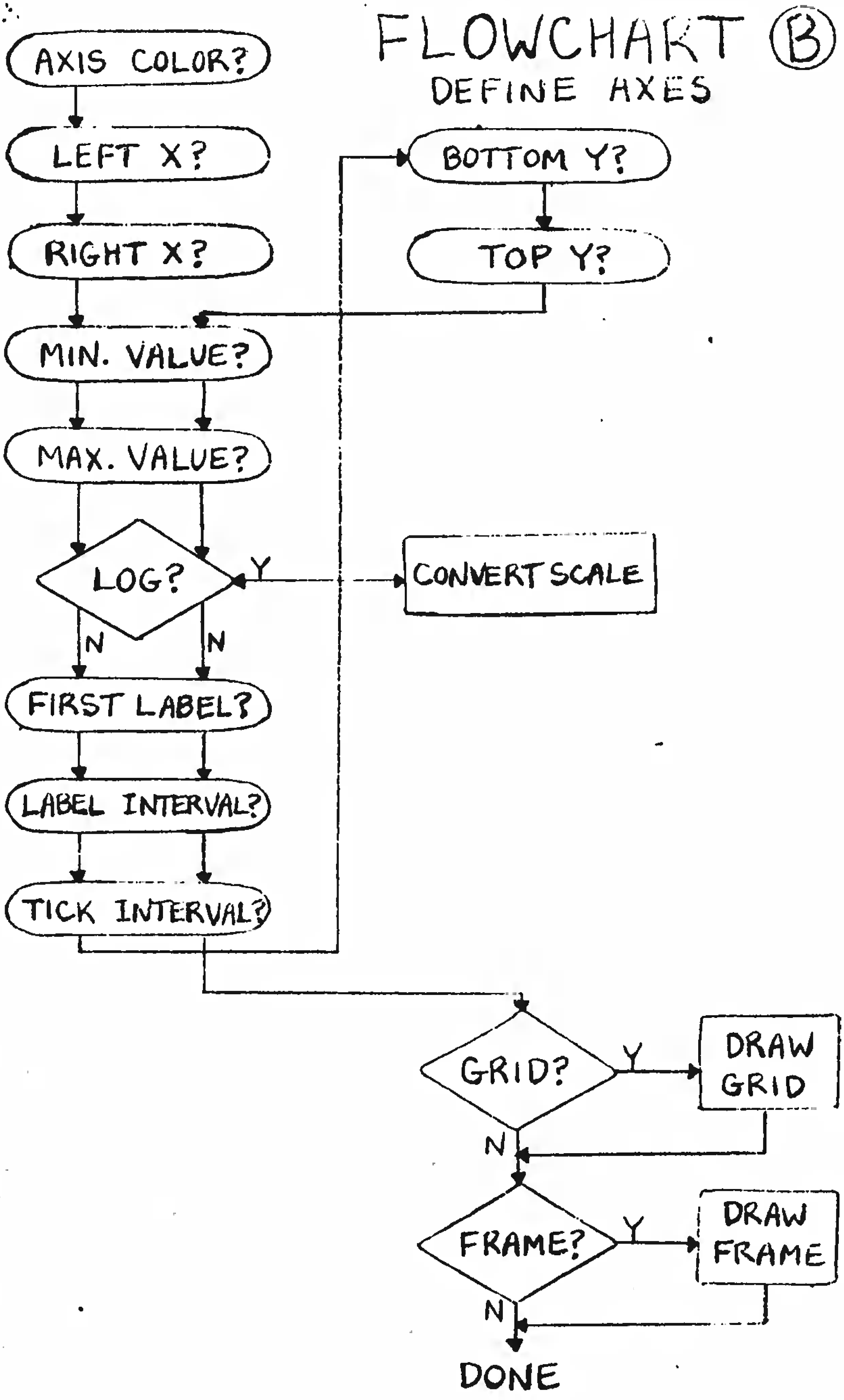
Typing N here will cause the program to skip the Define Axes Segment and continue with the DATA INPUT Segment. You should type Y if you want to go back and redefine one or both axes.

FLOWCHART (A)
OVERALL SUMMARY



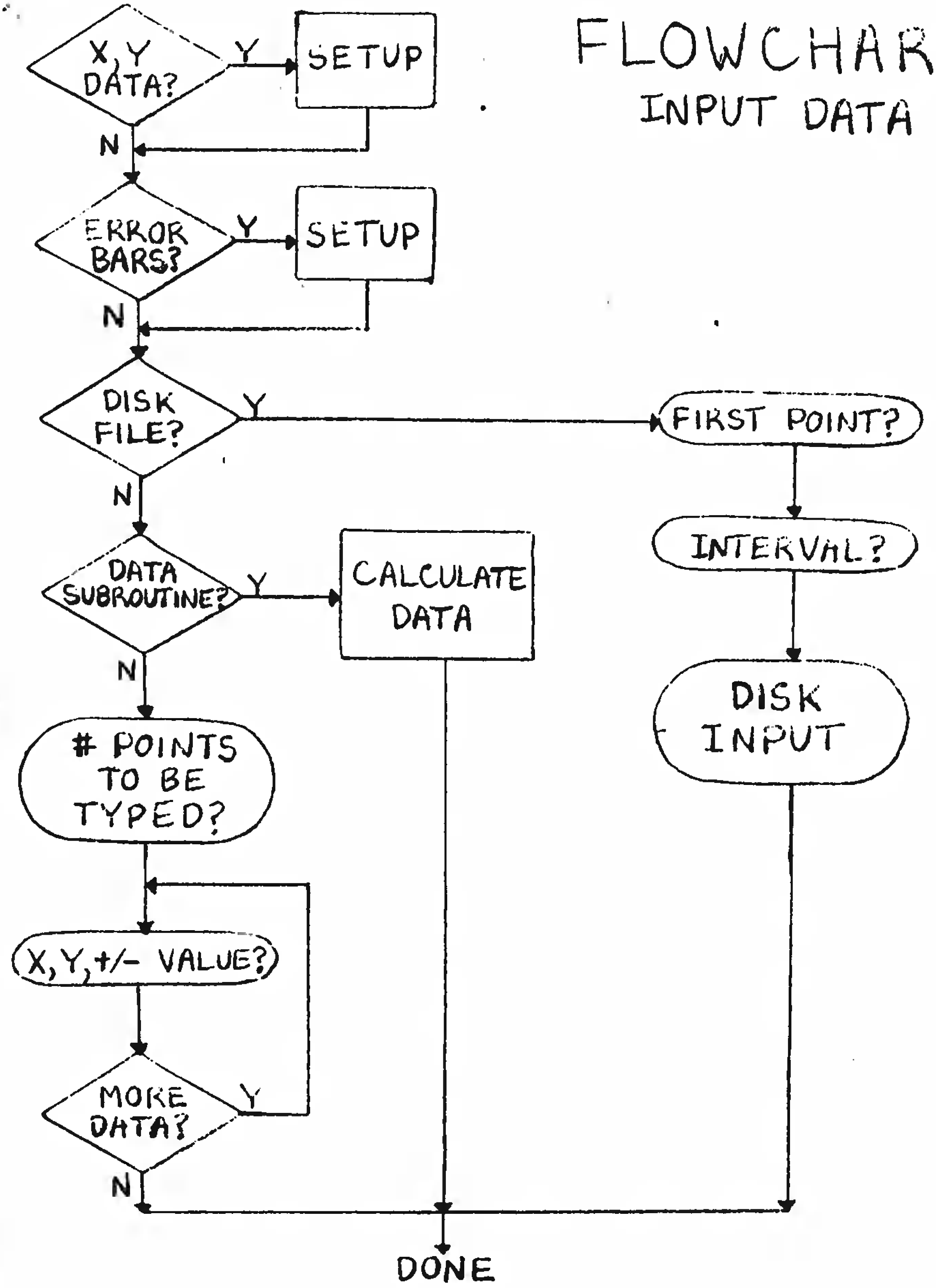
FLOWCHART (B)

DEFINE AXES



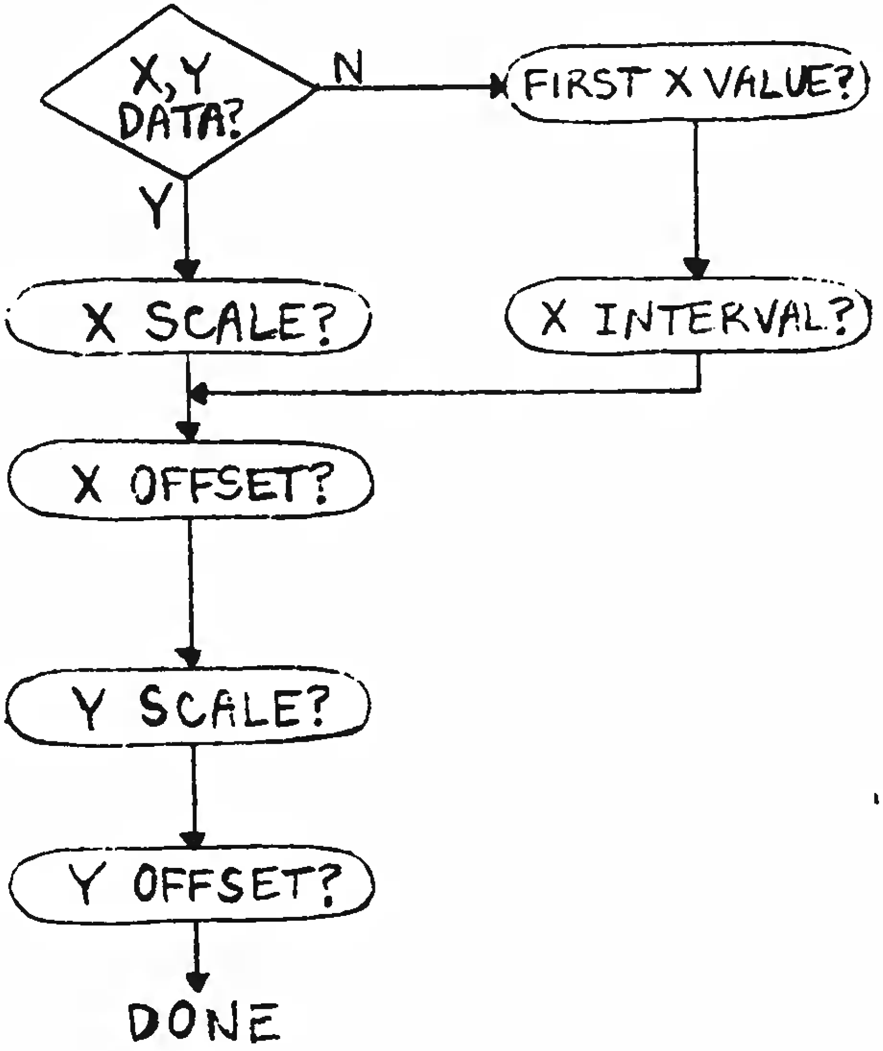
FLOWCHART C

INPUT DATA



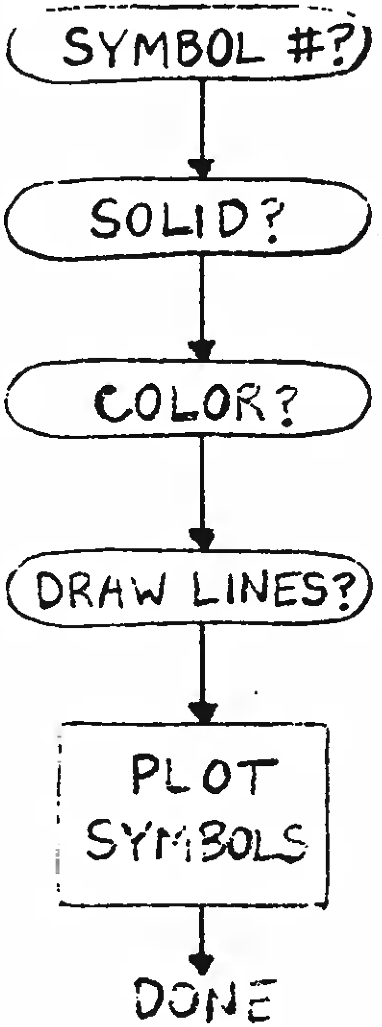
FLOWCHART (D)

SCALE DATA



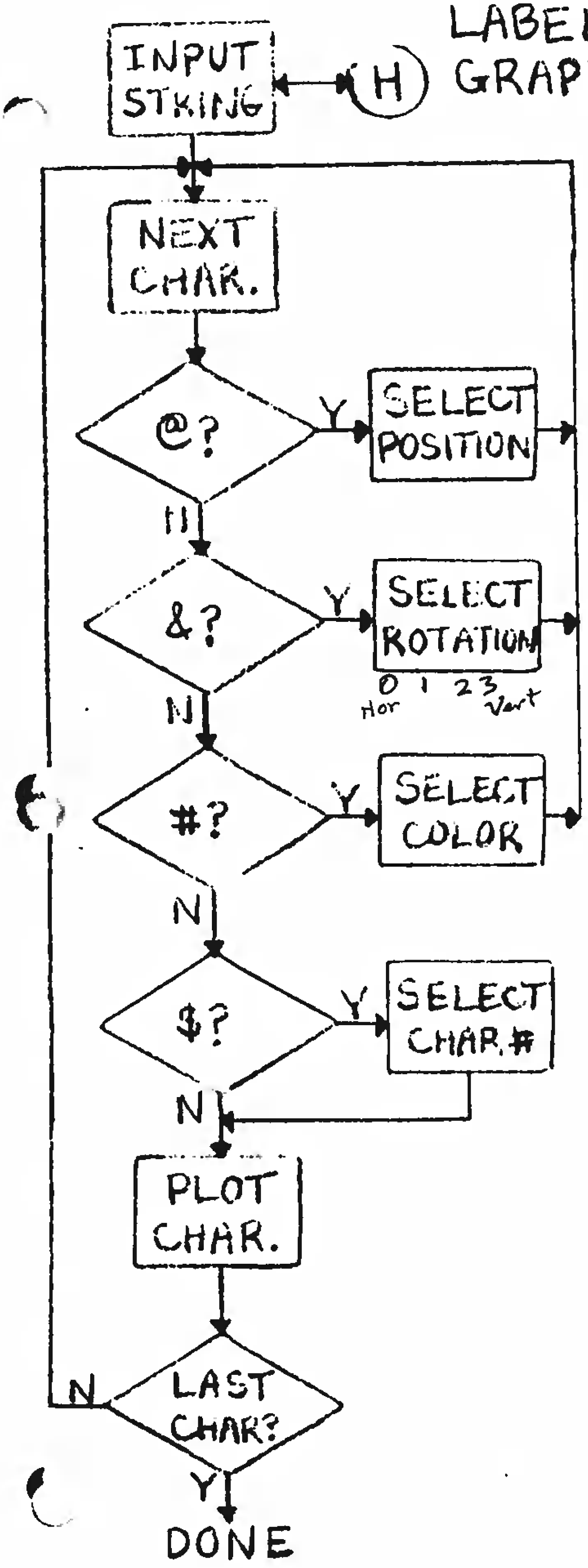
FLOWCHART (E)

PLOT DATA



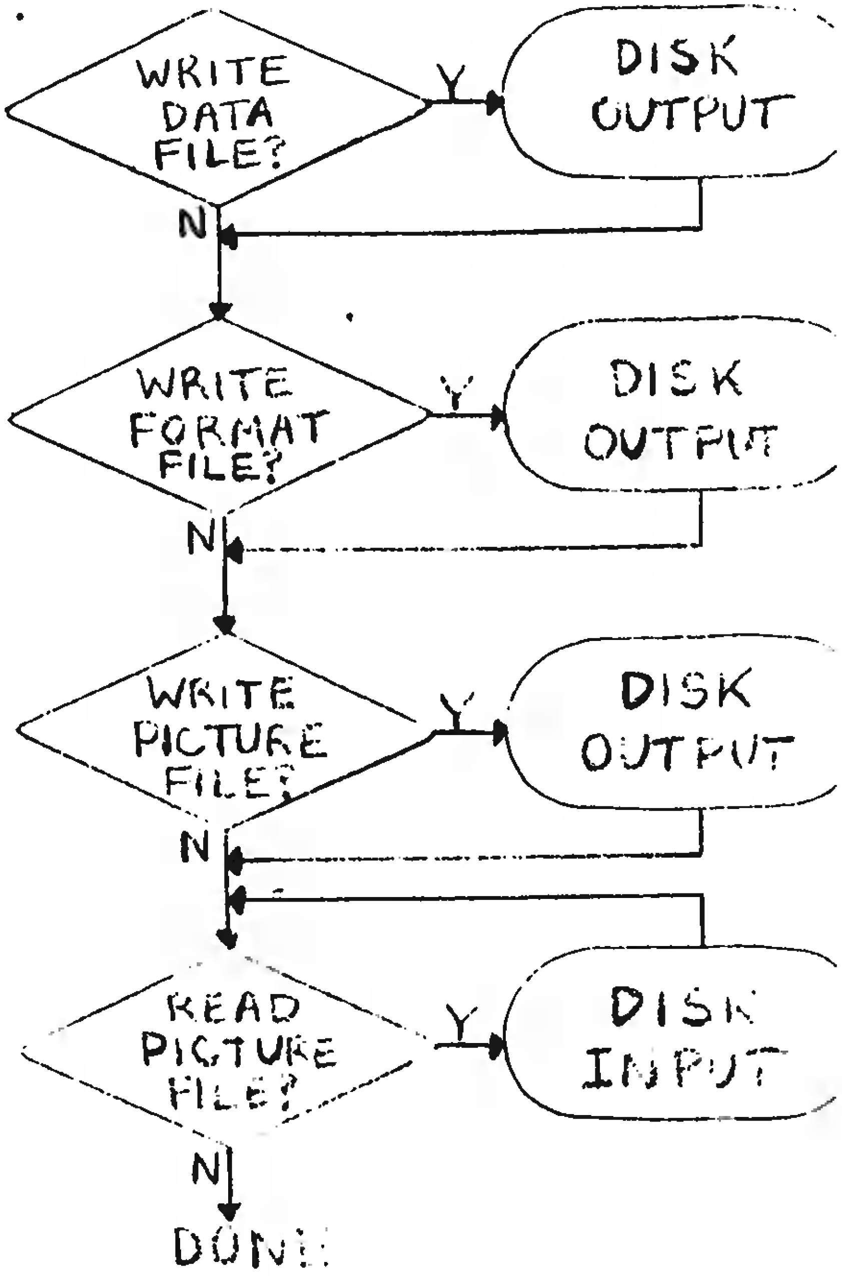
FLOWCHART (F)

LABEL GRAPH.

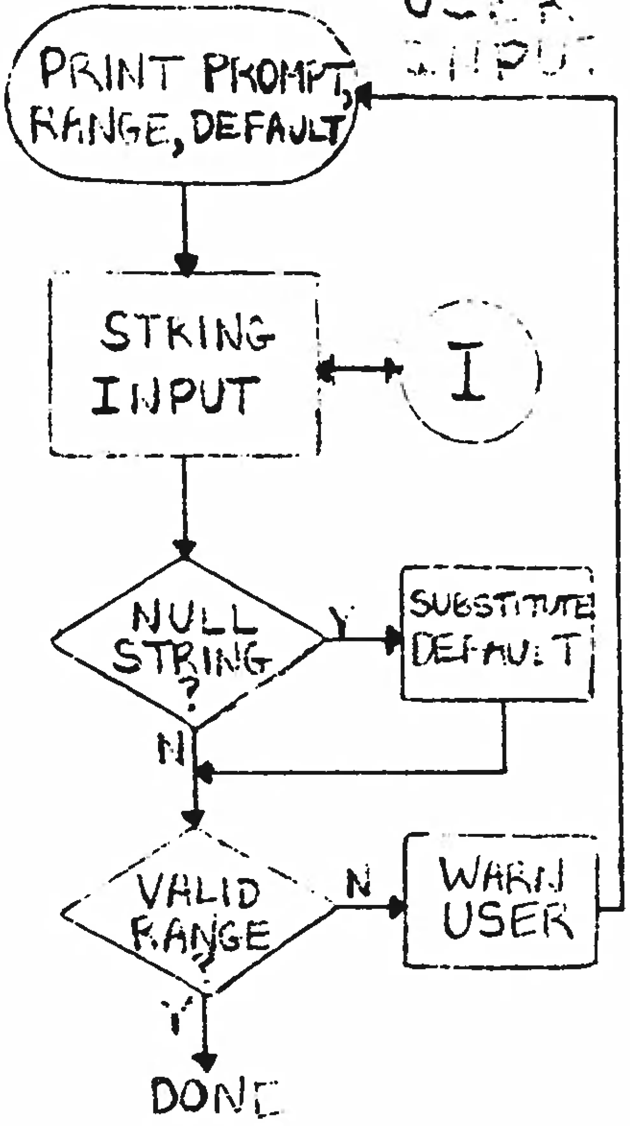


FLOWCHART (G)

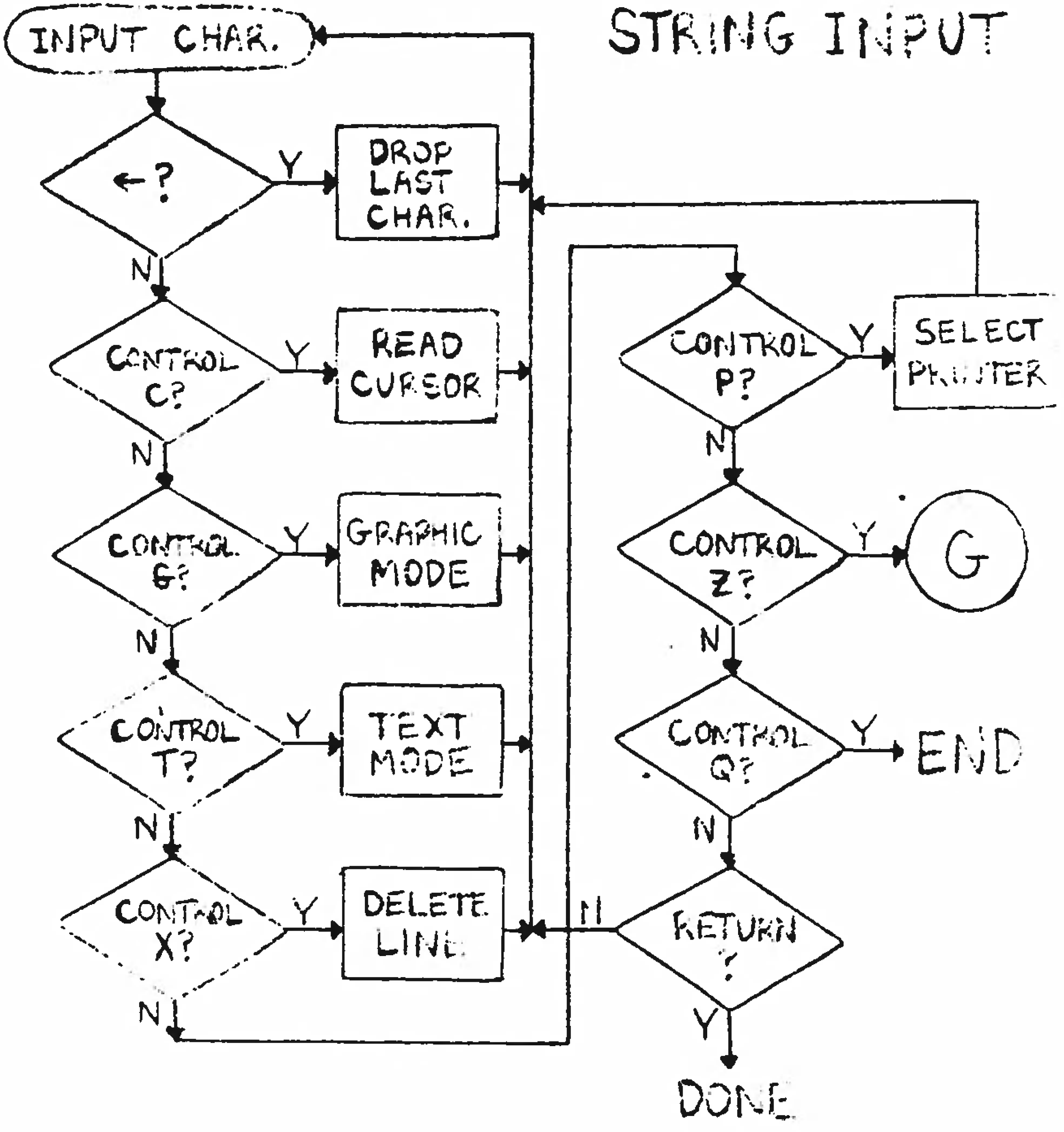
SAVE FILES



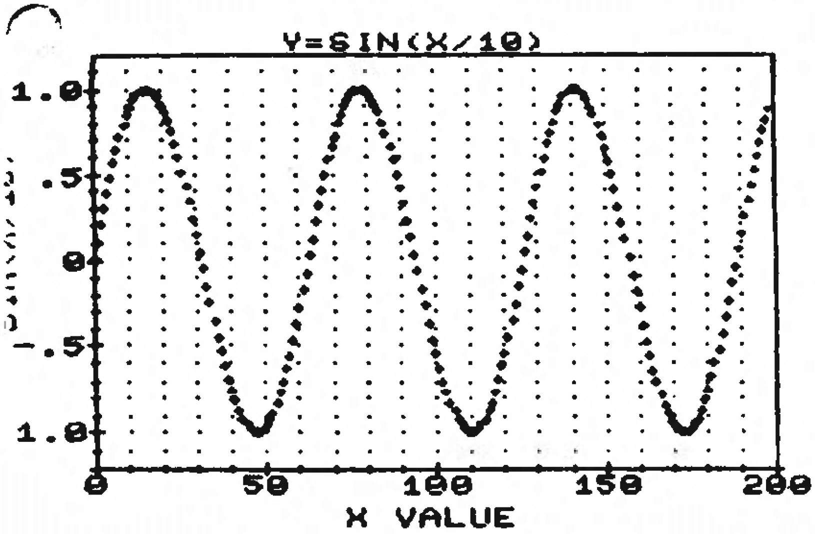
FLOWCHART (H)
USER INPUT



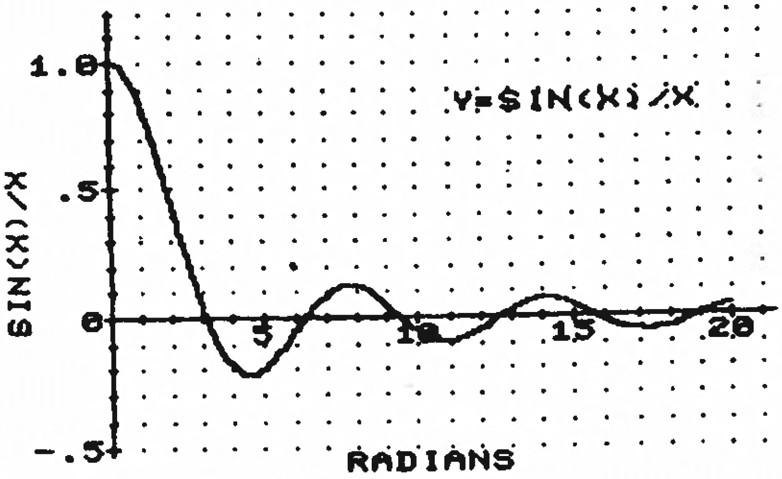
FLOWCHART (I)
STRING INPUT



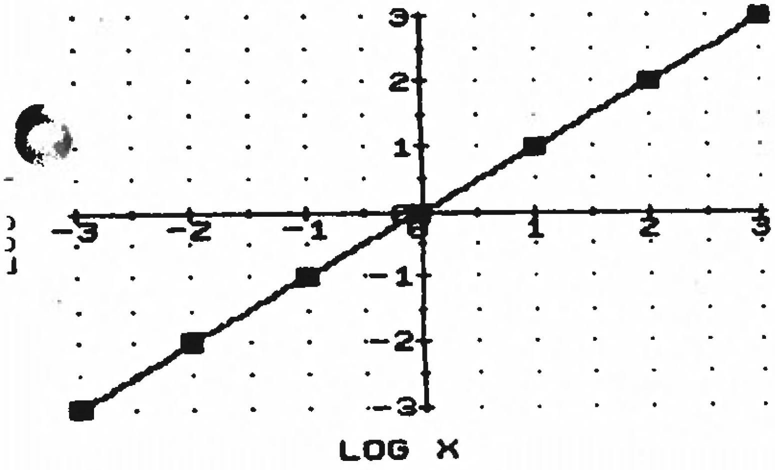
SCIENTIFIC PLOTTER DEMONSTRATIONS



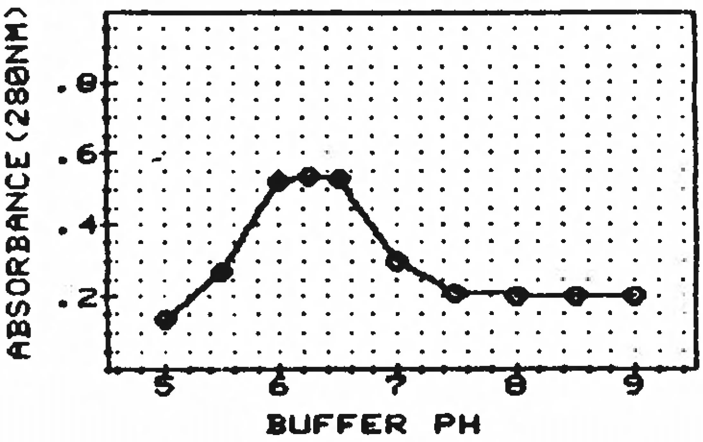
PLOT3000



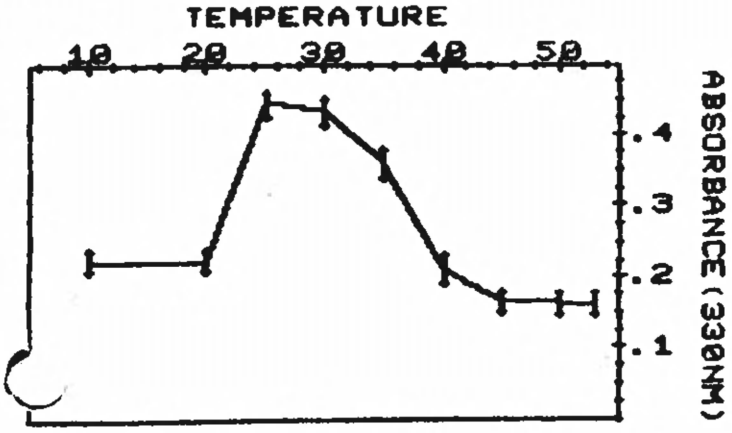
PLOT4000



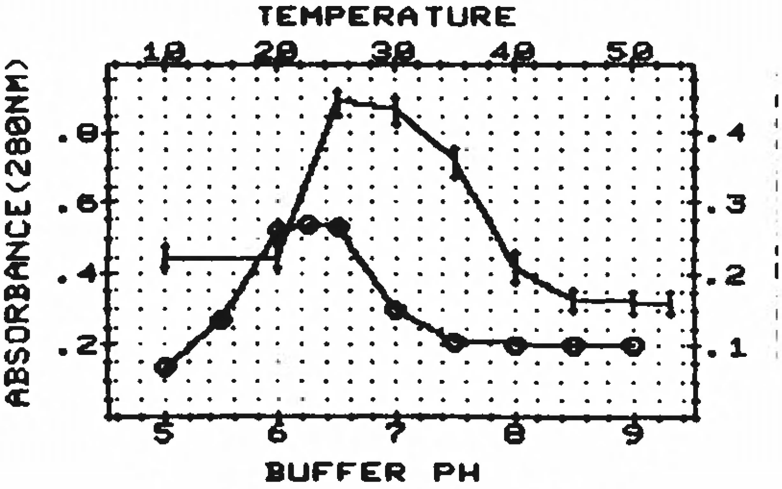
PLOTLOG



PLOTDUAL



PLOTBAR



PLOTDUAL + PLOTBAR